

Time of flight identification of ions for ERL

Eric Edwards

Supervisors: Georg Hoffstaetter &
Michael Ehrlichman

Why an Ion TOF Spectrometer?

- Scattering on the dilute gas by the beam produces positively charged ions
- Ions can then accumulate in the beam potential
- Possible 'cascade' effect
 - Disturb the motion of the beam
 - Widen the cross section (especially undesirable in ERL)

How this can happen, 1

- Fast ion instability
 - Ions oscillate in the electron beam and vice versa
 - Coupled system becomes unstable
 - Large oscillations or increase in transverse beam size

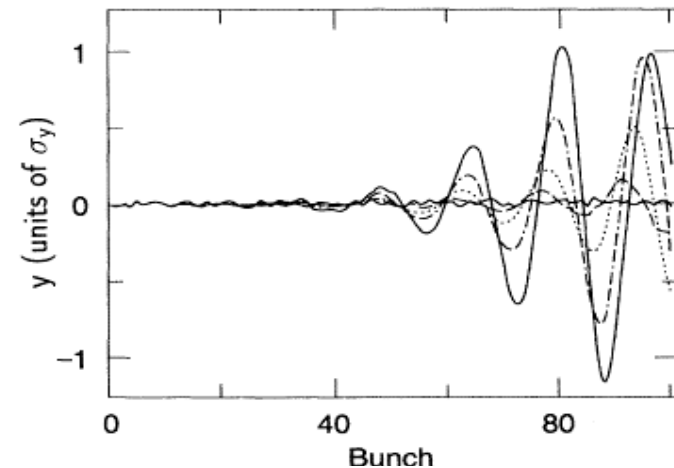


FIG. 1. Vertical beam centroid as a function of bunch number after a distance of 0 m (solid curve), 750 m (dashed curve), 1125 m (dotted curve), 1500 m (dash-dotted curve), and 1875 m (solid curve), respectively, for a train of 100 bunches, with an atomic mass of 28 (carbonmonoxide) and a pressure of 10^{-5} Torr in the arcs of the PEP-II HER.

Raubenheimer and Zimmerman
Phys. Rev. E **52** 5487 (1995)

How this can happen, 2

- Nonlinear focusing
 - Accumulated ions focus electrons non-linearly as a function of the electron's distance from the beam center
 - Emittance growth

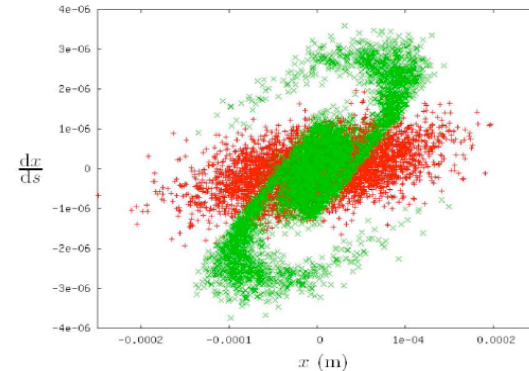


FIG. 8: Electron beam phase-space distribution after transversing the 100m ion field with $\beta^* = 100\text{m}$ at its center. Dark-red +: phase space in a free drift, Light-green x: phase space for motion through the ion field.

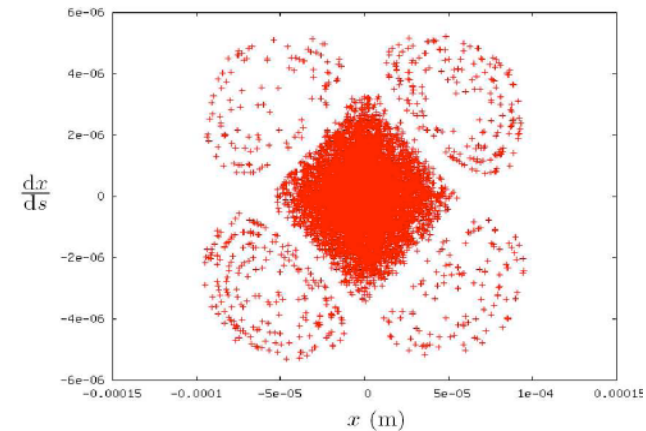
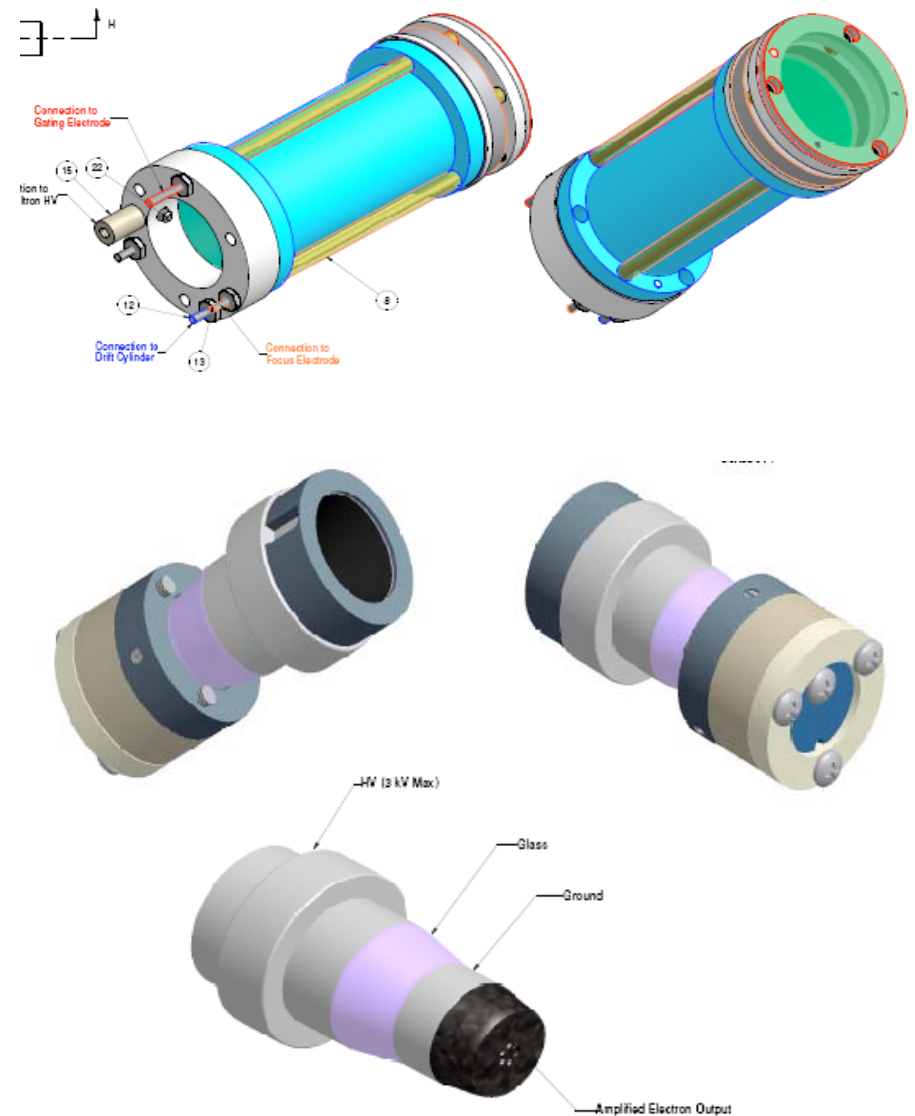


FIG. 15: Electron beam phase-space plot after transversing a 34m long region with medium high ion density 1000 times.

TOF Spectrometer

- Measure the composition of the ion gas near the beam
- Determine charge state and type of ions
 - Ions enter the TOFS chamber, are accelerated through a well-defined potential, then their velocities are measured
 - Determine mass to charge ratio



Timeline

- Electronics assembly
 - Gate ring circuit, HV divider-> finished
- Ion source for characterization
 - June 20
- Characterize detector
 - Correlation of measured voltages to measured ion density
- SIMION simulation of ion optics
- Trial installation on CESR?
- Test in ERL prototype injector